

SECTION 53

SHAFTING, BEARINGS AND PROPELLERS

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53.1 REFERENCES

(53A) **VOLUME V, OWNER - FURNISHED EQUIPMENT**

53.2 INTRODUCTION

This Section contains the Contractor Design and Provide general requirements for the Propulsion System Integration (PSI) Contractor's Propulsion Shafting System, and supplements requirements specified in other Sections of the Technical Specification covering ancillary systems and component parts of the Propulsion System.

1 *For WSF Fleet-wide Standardization purposes, End No. 1 of the Vessel shall always be*
2 *considered the bow, and this designation shall delineate port and starboard, fore and aft*
3 *wherever they are addressed in the Technical Specification.*

4 **53.3 GENERAL**

5 The PSI Contractor will be the supplier of the Propulsion System to WSF as set forth in
6 Reference (53A). The Propulsion System equipment will be Owner - Furnished Equipment
7 (OFE). The Contractor shall have total responsibility for installation, alignment, and testing
8 according to the PSI Contractor's requirements and the Technical Specification. The
9 Contractor shall design and provide all necessary foundations, and installation and set-up for
10 the Propulsion Shafting System and provide all installation, alignment, piping systems, set-
11 up, and testing required to produce a complete and operational system as set forth under the
12 different Sections of the Technical Specification, and as set forth in Reference (53A).

13 Each Propulsion Shafting shipset consisting of the propulsion shafting, bearings, seals and
14 propellers are OFE equipment in accordance with Reference (53A). One (1) shaft set shall
15 be installed at each End of the Vessel, as specified in Reference (53A). The propulsion
16 shafting system installation shall meet the requirements of ABS, 46 CFR and IEEE-45.

17 The Contractor shall receive and off-load the shafting, bearings, and propellers, shipped from
18 the OFE Vendor. The Contractor shall conduct a thorough inspection, with the WSF
19 Representative in attendance, to identify any visible exterior damage to components and
20 submit a written report to the WSF Representative within twenty-four (24) hours of the
21 off-load. The units shall then be stored indoors and adequately protected from weather,
22 damage, and deterioration in a heated, dry storage facility until such time as the units can be
23 installed shipboard. Once installed shipboard, all equipment shall be adequately protected
24 from physical damage and adverse environment as set forth in the *SECURITY AND SAFETY*
25 Subsection in Section 1 of the Technical Specification.

26 The Contractor shall provide all hydraulic fluid, lubrication oils, greases and any other
27 required operating fluids necessary for installation, commissioning, testing and trials of all
28 shafting, bearings and propeller systems, including as many changes necessary to
29 satisfactorily complete all tests and trials, until Delivery. All grease and lubrication oils shall
30 be the brand and the type as designated in WSF's current lube oils, grease, and fuel oil
31 contract.

32 **53.4 INSTALLATION ASSISTANCE**

33 The PSI Contractor and the WSF Representative will provide the Contractor with on-site
34 technical service and support personnel for the length of time and services as described in
35 Reference (52A) and Section 101 of the Technical Specification. The technical service and
36 support personnel will be to check and test the actual work done by the Contractor to ensure
37 the installation conforms to the Technical Specification and the PSI Contractor's
38 requirements.

1 **BE ADVISED:** The Contract Bid Support Package provides OFE documents and
2 drawings in Reference (53A) that contain specific installation
3 instructions setting forth mandated installation procedures and
4 precautions. The Contractor shall provide designs and installations
5 that, at a minimum, meet and address all instructions and
6 requirements as set forth in the OFE documents and drawings.

7 In the event the Contractor requires additional service or assistance of the PSI Contractor's
8 representative(s), the Contractor shall arrange for the PSI Contractor's services through
9 WSF. The Contractor shall be responsible to WSF for all such additional costs.

10 The Contractor shall notify the WSF Representative no less than ten (10) days in advance of
11 the time(s) the PSI Contractor's representative(s) is required on-site. The Contractor shall
12 provide to the WSF Representative a schedule of the anticipated need for the PSI
13 Contractor's representative(s). The schedule shall be based on a normal weekday using day
14 shift working hours. Any and all premium and/or overtime pay required shall be the sole
15 responsibility, of and at the expense of, the Contractor.

16 **NOTE:** The presence of the PSI Contractor's representative(s) does not relieve the
17 Contractor of the responsibility for proper equipment, component, or system
18 installation and testing. Any work undertaken by the PSI Contractor's
19 representative(s) other than that described herein and in Section 101 of the
20 Technical Specification, shall be done completely at the expense of the
21 Contractor.

22 **53.5 SHAFTING**

23 The Contractor shall provide all foundations, installation, and alignment of the OFE PSI
24 Contractor high speed shafting, low speed tail shaft, line shaft, and Main Engine to
25 Reduction Gear shaft for each End of the Vessel.

26 Tail shafting shall be capable of being withdrawn aft through the stern tube for purposes of
27 maintenance, repair, or replacement.

28 **53.6 STERN TUBES**

29 The Contractor shall provide a stern tube at each end of the Vessel that accepts the OFE PSI
30 Contractor Stern tube bearings, tail shaft, and stern tube seals as set forth in Reference (53A).

31 The Contractor designed stern tube shall provide access for internal piping connections for
32 the stern tube bearing temperature sensors and the stern tube bearing lubrication system as
33 set forth in Reference (53A).

53.7 STERN TUBE BEARINGS

The Contractor shall fit and install, at each end of the stern tube, OFE PSI Contractor stern tube bearings which shall be oil lubricated, as described by Reference (53A). The composite stern tube bearings shall be pressed into inserts, which in turn shall be aligned and fitted to the stern tube utilizing an epoxy chocking compound as set forth in Reference (53A), and according to the epoxy chocking compound Manufacturer's recommendations.

53.8 STERN TUBE SEALS

The Contractor shall install OFE PSI Contractor seals at the inboard and outboard ends of each stern tube to retain the oil in the stern tube bearing and to seal the seawater out at the outboard end. The stern tube seals will be as described on Reference (53A).

The Contractor shall provide and install all stern tube seal lubrication piping system components in accordance with PSI Contractor's design and requirements.

OFE PSI Contractor rope guards will be provided as set forth in Reference (53A). The Contractor shall install the rope guard systems at each outboard end in way of the stern tube and propeller hub.

53.9 STERN TUBE OIL SYSTEM

The Contractor shall provide and install the complete PSI Contractor designed bearing and seal lube oil system, including all tanks, pumps, valves, sensors, fluids, and all other components. Interconnecting piping and wiring shall be provided by the Contractor generally as described in this Section of the Technical Specification and Reference (53A). All equipment shall be installed by the Contractor to allow proper system function in accordance with the manufacturer's instructions.

NOTE: The Contractor shall be wholly responsible to provide the entire Stern Tube Oil System which meets the requirements of the PSI Contractor's design.

Any piping, which will not be serviceable after Vessel construction, shall be 316L stainless steel Schedule 120 with welded joints and shall be routed and supported to prevent vibration damage.

Except as noted, piping materials and preparation for service shall conform to the requirements of Section 74 of the Technical Specification.

53.10 LINE SHAFT BEARINGS

The Contractor shall provide installation of the OFE line shaft bearings which will be of the type described in Reference (53A). The bearings shall be installed on fitted steel chocks, or epoxy resin chocking compounds not less than one (1) inch thick and securely bolted to the

Contractor designed and provided foundations as set forth in Reference (53A) and the bearing Manufacturer's recommendations. The Contractor shall provide jacking bolts and base bolts assemblies as set forth in Reference (53A).

Line shaft bearing pillow block foundations shall include an extension of no less than six (6) inches on each side of the bearing to provide a hydraulic jack foundation/platform for shaft alignment checks. The jack foundation shall be suitably supported and stiffened so as not to deflect and give improper readings during shaft alignment checks. In addition, a coaming shall be installed around the base of each bearing pillow block (at top of foundation) to contain bearing grease. Coamings shall be in accordance with Section 70 of the Technical Specification, and without "valved" drains.

53.11 BULKHEAD SEALS

The Contractor shall install the OFE PSI Contractor bulkhead seals described by Reference (53A). The mounting of these split seals to the bulkhead shall be such that no cutting of the bulkhead shall be required for shaft removals. The Contractor shall install the PSI Contractor provided split liners at each of the high speed shaft bulkhead seal locations as set forth in Reference (53A).

53.12 CPP HYDRAULIC SYSTEMS

The Contractor shall provide (with exception of parts indicated as being supplied by the PSI Contractor as listed in Reference (53A) and install two (2) complete PSI Contractor designed CPP Hydraulic systems to service the OFE PSI Contractor CPP Hub systems in support of the PSI Contractor's System Design. The systems shall be designed and installed in general accordance with the methodology on current WSF ISSAQUAH Class Ferries, as set forth in WSF Drawing No. 8306-6352-053-01 (*latest revision*), *M/V SEALTH – CPP HYDRAULIC SYSTEM PIPING DIAGRAM*. The PSI Contractor will provide design assistance to the Contractor installation in accordance with this Section of the Technical Specification and the guidance in the Propulsion System RFP in Reference (53A).

NOTE: The Contractor shall be wholly responsible to provide the entire CPP Hydraulic System which meets the requirements of the PSI Contractor's design.

Each hydraulic system shall contain redundant servo hydraulic pumps, redundant drain pumps, and a hub oil pump for maintaining the hub oil at a certain level in the hub oil tank. The hub oil shall normally be provided by the exhaust oil backpressure when the system is operating.

Each system shall include all piping, fittings, valves, sensors, switches, pumps, controllers, tanks, gages, filters, strainers, heat exchangers, foundations, supports, mimic displays, and ancillary equipment to produce a complete and operable CPP Hydraulic Oil System to support the Propulsion Control System.

1 Except as noted specifically otherwise in specific Sections of the Technical Specification,
2 piping materials and preparation for service shall conform to the requirements of Section 74
3 of the Technical Specification.

4 **53.13 PROPELLERS**

5 The Contractor shall provide installation of two (2) OFE PSI Contractor controllable pitch
6 propellers, one (1) at each End of the Vessel, complete with Contractor provided associated
7 hydraulic oil system equipment as described by Reference (53A).

8 A removable rope guard shall be installed as set forth in the *STERN TUBE SEALS* Subsection
9 above.

10 Recessed padeyes shall be installed on the Vessel's structure to provide means for ready
11 rigging and positioning of the propellers as set forth in Section 5 of the Technical
12 Specification.

13 **53.14 SHAFTING ALIGNMENT**

14 The Contractor shall prepare an Alignment Procedure which includes the shafting, shaft
15 bearings, Main Engine and Reduction Gear. The Alignment Procedure shall use the strain
16 gage, hydraulic jack & load cell, or optical technique and shall meet all of the PSI
17 Contractor's alignment criteria. It shall include initial equipment alignment and final
18 alignment after the Vessel is afloat, all hull welding is complete, and all major machinery and
19 outfit are in place. The PSI Contractor plans on having a pre installation meeting with WSF
20 and the Contractor to assist and to agree to details for critical alignments. The Alignment
21 Procedure shall be prepared and submitted to the WSF Representative as set forth in Section
22 100 of the Technical Specification for approval **before** alignment is started. A final report of
23 the bearing reaction values shall be submitted to the WSF Representative for approval.

24 Alignment shall be coordinated to meet all the requirements of Reference (53A), this Section,
25 and Sections 50, 51, and 52, of the Technical Specification.

26 **53.15 SPARE PARTS AND INSTRUCTION MANUALS**

27 Provide a list of recommended spare parts and special tools, for those items which are
28 Contractor furnished, together with parts lists and instruction manuals necessary to maintain
29 and service provided equipment and accessories in accordance with the requirements of
30 Sections 86 and 100 of the Technical Specification.

31 **53.16 TESTING, TRIALS AND INSPECTIONS**

32 Tests and/or Trials shall be provided in accordance with this Section, and Section 101 of the
33 Technical Specification.

Inspections shall be performed as defined in this Section and in Section 1 of the Technical Specification.

53.17 PHASE II TECHNICAL PROPOSAL REQUIREMENTS

The following deliverables, in addition to others required by Section 100 of the Technical Specification and the Authoritative Agencies, shall be provided during the Phase II Technical Proposal stage of Work in accordance with the requirements of Section 100 of the Technical Specification:

A. Shafting Clearance Calculations

Shafting Removal Arrangements and Details shall depict salient details, rigging methods and capacities, and instructions required to remove and reinstall shafting.

Shafting Clearance Calculations shall demonstrate proper clearances between the propeller and stern frame structure, and between seal and bearing housings and rotating elements secured to the shaft within these housings. The calculations shall address those factors contributing to the axial movement of the shaft relative to the hull structure, including the following:

1. Thrust bearing axial clearances.
2. Axial deflections caused by propeller thrust.
3. Temperature differences (warm shaft/cold hull).
4. Hogging- and sagging-induced axial deflections.

For purposes of clearance allowances, the above listed factors shall be assumed to reach maximum values simultaneously.

See Section 100 of the Technical Specification for additional requirements regarding technical documentation.

See Sections 100 and 102 of the Technical Specification for propulsion shafting vibration analysis requirements.

See this Section, and Section 50 of the Technical Specification for documentation requirements regarding shaft alignment.

53.18 PHASE III DETAIL DESIGN AND CONSTRUCTION REQUIREMENTS

The deliverables required by Section 100 of the Technical Specification and the Authoritative Agencies, shall be provided during the Phase III Detail Design stage of Work in accordance with the requirements of Section 100 of the Technical Specification.

See this Section, and Section 50 of the Technical Specification for documentation requirements regarding shafting alignment.

- 1 See Section 100 of the Technical Specification for additional requirements regarding
- 2 technical documentation.

(END OF SECTION)